

**UNITED STATES DEPARTMENT OF EDUCATION
NATIONAL MATHEMATICS ADVISORY PANEL MEETING**

October 23, 2007

SUMMARY

The National Mathematics Advisory Panel met in open session at the Memorial Union Alumni Lounge, Arizona State University, Room 202, Tempe, Arizona, on Tuesday, October 23, 2007, at 3:00 p.m.

PANEL AND EX OFFICIO MEMBERS PRESENT:

LARRY FAULKNER	Chair
CAMILLA PERSSON BENBOW	Vice Chair
DEBORAH LOEWENBERG BALL	Member
A. WADE BOYKIN	Member
DOUGLAS H. CLEMENTS	Member
SUSAN E. EMBRETSON	Member
FRANCIS (SKIP) FENNELL	Member
BERT FRISTEDT	Member
DAVID C. GEARY	Member
RUSSELL M. GERSTEN	Member
TOM LOVELESS	Member
LIPING MA	Member
VALERIE F. REYNA	Member
WILFRIED SCHMID	Member
ROBERT S. SIEGLER	Member
SANDRA STOTSKY	Member
VERN WILLIAMS	Member
HUNG-HSI WU	Member
IRMA ARISPE	Ex Officio
DANIEL B. BERCH (VIA PHONE)	Ex Officio
JOAN FERRINI-MUNDY	Ex Officio
GROVER J. (RUSS) WHITEHURST	Ex Officio

PANEL AND EX OFFICIO MEMBERS NOT PRESENT:

JAMES H. SIMONS	Member
RAY SIMON	Ex Officio

DEPARTMENT OF EDUCATION STAFF PRESENT:

TYRRELL FLAWN, EXECUTIVE DIRECTOR
MARIAN BANFIELD
HOLLY CLARK
JENNIFER GRABAN
IDA EBLINGER KELLEY
JIM YUN

CALL TO ORDER

Chair Faulkner called the ninth meeting of the National Mathematics Advisory Panel to order. He welcomed the audience to the meeting where the Panel will start public work on the drafting of its Final Report. He asked about the audience's need for signing services, and there was no need for them. Chair Faulkner expressed an appreciation to Arizona State University for hosting the Panel.

Chair Faulkner stated that after the public comments, which will be the first order of business, the Panel would discuss the outline of the Final Report. The Final Report has been developed in draft form through the work of three synthesis teams that have worked largely by telephone and email for the past three weeks. Each team was asked to assemble a concept for the Final Report in the form of an elaborated outline, giving the most important findings and recommendations and suggesting an order of presentation.

The chairs of these synthesis teams worked the three concepts into a single Panel-wide first common concept, which was taken back to the synthesis teams for separate discussions and reactions earlier today. Over the lunch period the chairs revised the first common concept into a second common concept on the basis of reactions in the morning session. In this public discussion, the Panel as a whole will discuss the second common concept. The draft at this stage is a catalog of items suggested to be included in the Final Report, and not the language of the Final Report. The language of the Final Report will be drafted in the next few weeks on the basis of this catalog.

OPEN SESSION

PUBLIC COMMENT SESSION: DR. WILLIAM MCCALLUM, MATHEMATICS PROFESSOR, THE UNIVERSITY OF ARIZONA

Dr. McCallum is a mathematics professor at the University of Arizona and directs the Institute for Mathematics and Education. In addition, he chairs the education committee of the American Mathematical Society, and next year will start a two-year term as chair of the Conference Board of the Mathematical Sciences.

He started by thanking the Panel for its work in trying to create clarity and consensus around the problems facing mathematics and education in this country. The charge to the Panel covers an enormous amount of territory, almost an unmanageable amount. The Panel has researched and discussed teacher knowledge, instructional practice, student learning and core knowledge of school mathematics. It has navigated significant controversies on these issues and has discovered some areas of consensus and others where more knowledge and evidence is needed.

Effective next steps will require the energy of many stakeholders: mathematicians, educators, teachers, administrators, policy makers, and business people. He did not tell the Panel to add anything more to its report, but focused on how to harness and direct the necessary energy.

The Panel's report will join a series of reports by distinguished groups going back over the last 25 years at least, starting with a *Nation at Risk* in 1983, through the Glenn Commission report, to the recent National Academies report *Rising Above the Gathering*

Storm. The Panel's recommendations might be different from those in these reports, but their fate might be the same. Although there is some movement in education reform, the general record of follow-up on these reports is poor. As the Panel winds up its work, it must be wondering how to beat that record.

Fran Leibowitz said that the opposite of talking isn't listening. The opposite of talking is waiting to talk. Right now there are plenty of people in the national education arena, especially in Washington, who are waiting for their turn to talk. Those of us spread throughout the rest of the country who care about mathematics education are obliged to start thinking now about how to turn the Panel's report into a process of listening that leads to action, not more talk.

The immediate purpose of the Panel's report is to inform the legislative agenda at the federal level. However, they cannot wait for whatever legislation might materialize. What also is required is urgent national deliberation, conducted in school districts, state houses, state boards of education, and national organizations.

Dr. McCallum suggested that the Panel join a coalition of institutes, centers, and programs to organize a series of follow-up meetings around the nation. These meetings would mine the Panel's work and extract nuggets around which to build their own agendas for action and programs for research. An important resource would be not only the Panel's report, but also the rich set of documents the Panel has accumulated during these periods of public comment, especially in areas where the Panel has not yet found common ground.

Some meetings would have a focus on influencing policy, taking recommendations from the Panel's report that can be turned into immediate action. For example, there is much that institutions of higher education can do right now in teacher preparation and professional development. Other meetings would pick up the ball in areas where more research is needed and develop research agendas of their own to fill in these gaps.

Dr. McCallum stated that the Institute for Mathematics in Education stands ready to step up and fill the role of convener. It has the capacity not only to run some of the meetings envisioned in his proposal, but also to collate and orchestrate the efforts of other centers. The Center specializes in bringing together communities that are sometimes worlds apart: mathematics departments, colleges of education, school systems, government agencies, business, and commercial and non-profit education organizations.

Dr. McCallum has made preliminary contact with some of the organizations that might help carry out this work, such as the Mathematical Sciences Research Institute in Berkeley; the Focus on Mathematics Project at Boston University; the Center for Science, Mathematics and Computer Education at the University of Nebraska; the Center for Mathematics Education at the University of Maryland; and the Center for Research on Education in Science, Mathematics, Engineering and Technology at Arizona State University. There are many more centers he has not had time to contact but which he is sure are ready to join such an effort.

Chair Faulkner responded that the question of what follow-up will happen is always a question for a group that undertakes a study like this, and he stated that they do not yet know the answer. The responsibility to follow up will likely be diffused over many agencies, organizations, and authorities. That actually gives the Panel some hope

that there will be action, because they are not quite as dependent on the idea that a single power or a single authority will act.

PUBLIC COMMENT SESSION:

MS. JANIE ZIMMER, NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS BOARD MEMBER AND RESEARCH-BASED EDUCATION, LLC

Ms. Zimmer is from Research-Based Education, LLC and spoke on behalf of the National Council of Supervisors of Mathematics (NCSM), a group of leaders in mathematics education. She stated that NCSM greatly appreciates the Panel's work throughout the past year and a half. They realize how important the Panel's task is and they are hopeful that the Panel's Final Report will have an impact on the nation's children. NCSM appreciates the opportunity to provide input, in addition to the written comments sent.

NCSM's input touched upon several issues, and the most critical of those is equity, or the opportunity for every student to achieve at a high level in mathematics. As they examine the total work of the Panel, they currently see few references to equity and the opportunity for every student to be prepared to be successful in algebra. They note the references to students with learning disabilities, and gifted and talented students, but at this time, they do not see the work of the Panel addressing the needs of those from poor families, those whose native language is other than English, those who have diverse learning styles, those students of color, and those who have strong and different cultural backgrounds.

Ms. Zimmer shared that Robert Manzano, in his most recent book, *The Art and Science of Teaching*, references many affirmed research studies that highlight the importance of planning for instruction that can significantly impact student achievement. He emphasizes percentile gains based on teacher actions and commitments.

In the third annual Brown Lecture in Education Research, Linda Darling-Hammond presented *The Flat Earth and Education, How America's Commitment to Equity Will Determine our Future*. The U.S.'s poorest, most needy students often have the least access to the best teachers and proper resources, she states. Study after study documents that there are significant differences in factors such as class size, school size, teacher quality, curriculum quality, and availability of resources and equipment in what is found in our affluent, suburban schools compared with the center city schools that are the homes of our African-American and Latino students. Much of the difference in school achievement between minority students and others is due to the effect of the unequal school opportunities, and in particular, greatly diverse access in high-quality teachers and teaching.

In addition, Ms. Zimmer states, tracking persists in the face of growing evidence that it does not substantially benefit high achievers and tends to put low achievers at a serious disadvantage, in part because good teaching is a scarce resource and thus must be allocated.

Possibly more than any other recommendation, the recommendations of equal access, equal opportunity, and equity are the ones that need to be made by the Panel, and

need to be made very strongly, so that students who are now truly left out will be given a strong education.

PUBLIC COMMENT SESSION: QUESTIONS AND ANSWER PERIOD

Mr. Williams asked in reference to Ms. Zimmer's statement about differences between quality of services offered to lower income students and middle class students, including the quality of curriculum and what she thought the differences in curricula were. He also asked if she had heard of Project Follow Through and what was her opinion of it. Ms. Zimmer responded that in Baltimore City and Howard County, where she has worked, the quality of curriculum is not at all to be compared.

She explained that curriculum is designed by teachers for the most part in the school district in which the teachers are teaching. The curriculum in Howard County is presented in a way that a teacher can look at that teacher's grade level and see what was done in the previous two or three years and what will be coming in the next few years. In Baltimore City the curriculum is much older and it is not seamless.

Ms. Zimmer stated that she couldn't comment very specifically on Project Follow Through. She added that in Philadelphia, Reading, and Gettysburg, where she has also worked, the curriculum is not strong. Mr. Williams asked if she could identify some characteristics of a strong curriculum. She replied that a strong curriculum needs to identify to the teacher exactly what is it at this grade level that the students are responsible to master. It also states what the teacher should introduce, what the students should master at the grade level, and what the teacher should maintain at the grade level. Also, a strong curriculum should place the content of the grade level in context of what comes before it and what comes after it.

The Panel stated that teachers should know at least what they are teaching or what their grade level is teaching. Ms. Zimmer stated that she has a problem with that and NCSM addresses that in the comments they sent in. They believe a teacher needs to know far beyond what they are teaching. Because if they are teaching a third grade class and a child asks a question that is beyond that lesson, how do they respond to that? How do they prepare their third grade students to be successful in fourth-and fifth-grade mathematics? They cannot do that just by knowing what they are teaching at that grade level.

The teacher needs to extend beyond what the curriculum is, but with a focus on and the ability to test what it is that they are responsible for, so that students can master that grade level's material and be prepared for the next grade level.

Dr. Loveless asked about the two states that Ms. Zimmer mentioned, and stated that Pennsylvania and Maryland both have had math standards and frameworks for a while. He asked to what extent is what she laid out to the Panel the fault of the state standards, or should the state standards be focused more so that this kind of thing does not happen. Ms. Zimmer responded that she is not sure she blames the state standards. Maryland has changed their standards from the more integrated program, to a more rigid, discrete type standard program. She blames the curriculum in the school districts, the preparation of the teachers, the resources available to school districts, and policies around children with learning disabilities.

Ms. Zimmer stated that for children with learning disabilities, the urban school districts are really falling back. While there are 13 or 14 different categories of learning disabilities, only one of those is low IQ. Yet when a student is in a class and has an Individualized Education Plan, teachers have an attitude that this child is not up to par with everyone else. She stated that they should use the research on children who are not native English speakers and children from poor families to figure out how to have those students achieve in mathematics.

Ms. Zimmer stated that the technology component is an important one and Marc Prensky talks about that. Teachers need the training, and people need to keep open minds about these new ideas. Some counties have good training programs, but they need to look at some of the inner cities that do not.

Dr. Ma asked whether the students who are being tutored for learning disabilities in math are the same who are tutored for disabilities in reading. Ms. Zimmer responded that many times especially in elementary school, children are grouped according to ability in reading. Math just goes along with that ability in reading. Ms. Zimmer stated that she shared with the Panel five or six references of research that are showing that classes that pull out gifted and talented students are not really beneficial for low-ability, or gifted and talented students.

Dr. Ma followed up by asking if these were the same groups of students. Ms. Zimmer responded that these are different categories of students who are learning math and English. There are a lot of students here from other countries who are learning the English language along with learning their mathematics. They might not understand the language in the classroom and might have a difficult time learning the mathematics, but that is not necessarily a learning disability.

Dr. Boykin stated that many of Ms. Zimmer's statements about equity focused on teachers and teaching quality. Given that she represents NCSM, he asked what role supervisors play in dealing with equity matters. Ms. Zimmer responded that supervisors play a large role, but they need to have access to the teachers. In large urban districts supervisors may see the teachers once at the beginning of the year, maybe a half-day or a full day in February, and maybe one other time during the year. They also have an opportunity to visit them in the classroom, and hold voluntary workshops. Suburban districts have two or three days in the summertime where they have access to all teachers. New programs are not voluntary, and afternoons are scheduled when teachers will come together for additional training and for sharing sessions.

Ms. Zimmer added that she sees new teachers begin teaching in Baltimore City because that is where they could get a job. After two, three, four, or five years they move to a county system because the pay is higher and the resources are much greater.

NATIONAL MATHEMATICS ADVISORY PANEL: SECOND COMMON CONCEPT PAPER DISCUSSION

Chair Faulkner described the process for the review of the Second Common Concept paper, where the Panel would only address major elements, findings, and recommendations that are in the current concept paper. The session will address the degree to which there is agreement or disagreement on each point so that they can build a catalog of items that are largely settled for inclusion in the report, and another set of

items that will require more debate. The paper includes ideas that are suggestive about what might be included in the report.

From this concept document, a draft will be built that will largely be made up of language taken from the working papers of the task groups. The session will take the current concept paper section by section.

Chair Faulkner described that the Second Common Concept paper differs from the First Common Concept as it quickly begins with the more impactful language, and not with the more operational information about how the Panel was charged, who the members are, and where they met. There is room for an executive summary, which will be added later. The introductory comments in the first paragraph or two will quickly indicate that the Panel arose from presidential executive order. It will provide a reference as to where the membership list can be found and then it will provide a reference on how the Panel's work was carried out.

The appendices would be A, the presidential executive order; and B, the rosters of the panel members, staff and consultants. Appendix C is the summary of the Panel's method for pursuing its work, the task groups and subcommittees, the synthesis and submission of this report, and the standards of evidence. Appendix D includes the locations and dates of the meetings. Appendix E is the roster of the task groups and subcommittees. The introduction begins with "the case." This will start the document with a strong discussion about the state of math education in the country and the need to address this set of issues. It will include the root of the President's charge and the concerns behind the executive order, including college-going and college graduation rates, preparation of the workforce, points made in *Rising Above the Gathering Storm*, and mathematical performance on international competitions.

Chair Faulkner asked for comments on "the case" section. Dr. Stotsky asked about the references in the report to resources, gaps in resources, and making investments, which she does not see as the focus of the Panel. What she thought they were trying to do was to make sure that they had a focus on the content of mathematics, content goals for K through seventh-grade teachers, assessments that would address the content of mathematics, instruction that would address the content, and so on.

Chair Faulkner stated that the synthesis groups were not actually asked to address this part of the document, but they were told that there would be such a section.

Dr. Schmid stated that the word "resources" is used as a synonym for sources, and "investments" as a synonym for basis. Using the words resources and investments, respectively, suggests that there's a lot of money, and that's not what the Panel is saying. He stated that those two words are out of place in that section.

Dr. Boykin stated that his synthesis group offered up particular points to help frame the overall message. He added that some of the points in "the case" might be seen as merely summaries of general findings from the body of the report. He would like to see points that state how people would move these things into the classroom where real kids can receive good instruction from real teachers.

Dr. Fristedt shared Dr. Stotsky's and Dr. Schmid's concerns that it is a misleading story.

Dr. Reyna stated that one of the tasks that this Panel had from the beginning is not only to speak to the content of mathematics that ought to be taught as well as policy and practice, but also to recommend research and areas for further research. She suggested

that these recommendations belong with the other recommendations to make it flow more smoothly. But she does think that recommendations for research may be among the most valuable contributions of the Panel.

Dr. Ball stated that they have been worried since the beginning of the Panel's work about how the report will have the impact they all hoped it could have and how it could make some difference for policy and practice. Her group noticed that there is an astonishing agreement about one major thing, which is about what students should learn and how kids learn. One big problem is the question of what it will take for that to actually reach classrooms, be used by teachers, and be a part of real, usable policy.

Dr. Ball's synthesis group proposed that the big points convey what they feel they have learned. Two of the task groups were able to say quite a bit and two others, after a lot of work, discovered that there is not a lot known in those areas.

Dr. Stotsky stated that talking about the need for money for research does not correctly characterize why the Panel was put into being and what it should be saying as the outcome of the Panel. It's not a new statement. The other reason why she is concerned about that angle is that they had very poor yield from most of the research they looked at. To then advocate for more money for something that they were not able to use sounds self-serving. What they need to focus on is changing the way people look at what the purpose of education is and what the purpose of mathematics education should be.

Dr. Wu observed that the impact of mathematics education research or mathematics education itself has been uncertain, and that is an important point. He added that the whole point of writing this report is to have an impact. From that point of view, all of their findings will be of no value unless they put them into the classroom. The implementation part requires more attention in the report to teachers. The agents for carrying out the recommendations in the classroom are the teachers.

Dr. Geary stated that the major reason that mathematics education has been a concern for the past 50 years is because of the poor research base. In order to know what is going to effectively work or not work and how to implement that, there need to be systems in place to evaluate and test different types of approaches to instruction or learning. If the Panel members back away from a research base, they will be backing away from a scientific base upon which they are trying to improve the field. Chair Faulkner added that the executive order actually includes in Section (g), the need for research in support of mathematics education. So the Panel has an explicit charge to address the research base. Chair Faulkner stated that there has not been much time to review this part of the report and as long as everybody has added their comments, he would cut off the debate so that they could move on.

Dr. Fennell stated that he agreed that this part of "the case" had punch and that it sets up the report. He also agrees with Wilfried that they can change a couple words and not have it be all about needing more money, but that if they say something about the need for research, it will be suggestive of funding in one way or the other.

Dr. Loveless agreed that the case has to be punchy and state the problem. It also should state why the Panel was created. He stated that recommendations should come later in the report. They need to say something about how the Panel found evidence on how kids learn math, on the mathematics they need to learn, but there is still a gap in moving that knowledge into the classroom.

Dr. Faulkner then moved to the content of school algebra and the critical foundations for it, the starting point for the place where the synthesis groups were asked to develop material. The synthesis group chaired by Dr. Siegler group suggested that it would be a good idea to bring forward the Critical Foundations to match up to the Major Topics of School Algebra, and to also possibly bring the Benchmarks forward.

The decision was to bring forward the Critical Foundations in a foreshadowing way and let them be discussed more substantively in the Learning Processes section. They left the Benchmarks in the Learning section because they seemed better placed there. Chair Faulkner opened up the discussion of the section called The Content of School Algebra and Critical Foundations for It, which goes from the subhead "In acquiring knowledge" -- down to the major head "Acquiring Knowledge and Skills Needed to Learn Algebra," or lines 81 to 108.

Dr. Fristedt stated that on line 97 and 107, he would like a table. He also would like to see a definition of the word algebra. He feels this is necessary because the National Assessment of Educational Progress (NAEP) has an algebra strand as low as fourth grade. But that is not what is being discussed here. A good criterion in his mind is ratio and proportion and whether that part of the material precedes algebra or is it part of algebra.

Dr. Loveless would like to see the Benchmarks brought up to the top right after the Critical Foundations. The reason is that one of the major flaws of math education in his view in the 20th Century has been a confounding of process and content. A reader will see the question answered, "What is Algebra," which is very clearly done. The Critical Foundations are not as clear. He'd rather see bullets that lay out the content. He also stated his concern with the phrase "Acquiring the knowledge and skills needed to learn algebra," which might mean the reader will find the critical skills needed to learn algebra. They will find other skills.

Dr. Fennell agreed with Dr. Loveless that they are communicating clearly the mathematics target, algebra, and how they are defining algebra, what is necessary before algebra and when they should learn it.

Dr. Schmid stated that the Benchmarks were purposely and advisedly kept spare because they are guideposts. They are right to be placed there, as they are an integral part of talking about the critical foundations.

Dr. Ma asked if the Panel would address the two algebras—the one in elementary schools and formal algebra. Dr. Fennell responded that the Assessment Task Group quotes Hyman Bass' definition and talks about the concerns with regard to overemphasis of patterns in assessments. They have been very specific about talking about ratio and proportion in particular as fitting into that cluster of Critical Foundations and not calling that algebra, for instance.

Mr. Williams stated that because things like pattern recognition are studied in second grade, they would get away with calling this algebra. The Panel needs to make a strong definition, period.

Dr. Fristedt stated that it is important to deal with this issue quite explicitly, because we can have internal agreement here, but there are so many readers out there. He would like to bring "arithmetic" back into use more, while he realizes that when it's used by itself, it tends to focus on calculation facility, not on the number line and other aspects of number.

Dr. Schmid stated that the Conceptual Knowledge and Skills report makes an effort to define algebra by capitalizing it to show that it represents material that is customarily taught in an algebra course.

Chair Faulkner then moved to the next section on acquiring the knowledge and skills needed to learn algebra. It begins with Readiness for Learning and What Children Bring to School, and a lot of what was emphasized in the Learning Processes report. Dr. Clements' synthesis group provided an alternate concept for this section.

Dr. Clements stated that they used Readiness for Learning as number one. They brought in points about the interplay of conceptual and procedural knowledge; attitudes, beliefs, and motivation; stereotype threat; and other points they felt were very important. These are general psychological principles that apply to all mathematics learning.

Dr. Schmid did not agree with that order because it does not get quickly enough to the math content. He felt there is great symbolic importance to the fact that the content comes very early and that it is separated from those other issues.

Dr. Loveless asked what the main benefit would be of doing it this way. Dr. Clements stated that they kept seeing these things interspersed in the different areas but they made general points. And some of these points were not in the report at all.

Dr. Wu stated that he prefers the original approach to this one. He would like to see a short document that will be as impactful as possible and get to the heart of the matter within the shortest time.

Dr. Boykin felt that the issues around learning and learning processes that transcended any particular content area of mathematics were lost in the first concept paper and they thought they needed to have a life of their own. Doing it this way shows people that these are generic processes that would enhance or be involved whether it's geometry or algebra, whatever the case may be. The other point he feels is critical is that the collateral processes of learning, such as the socio-emotional, equity, children from different backgrounds, and ethnic and racial differences, are matters that transcend particular topics in math.

Dr. Whitehurst stated that he might agree with what is being presented, but he needs to see these two versions side by side.

Dr. Reyna agreed with Dr. Boykin that putting these issues within different subheadings would be a mistake. They directly bear on important policy issues that are currently framing not only research, but practice. The interplay between conceptual and procedural knowledge is a theme that they have talked about where there is a false dichotomy.

Dr. Siegler stated that his group's version was an attempt to integrate the Conceptual Knowledge and Skills and Learning Processes themes. They kept the content of algebra up front and separate from the learning material. But he thinks that having these learning themes up front actually makes a lot of sense. They are not talking about a lot of space here. These themes logically transcend any particular content area.

Chair Faulkner said that he would draft both sections to see what they both look like.

Mr. Williams stated that since there is not likely to be agreement on issues such as different learning styles, learning processes, and equity, they should focus where there is agreement and that is content.

Dr. Boykin stated that he is sensitive to leaving out issues of ideology or belief and whether there are or are not learning styles per se. What they did in this section was to let the data speak for itself.

Dr. Schmid stated that after this presentation he agrees that it makes sense to have all of these issues together. Because there is so much agreement on content, they should let it speak for itself and then they talk about these other issues, which are important and they need to be addressed.

Dr. Fennell stated that Dr. Reyna and Dr. Siegler made a good suggestion of using these general principles of learning to frame the discussion.

Dr. Benbow stated that these general principles also could be used to sum up at the end.

Dr. Schmid stated that there is some degree of convergence to preserve the integrity of these particular issues and not interrupt the discussion of content.

Dr. Sielger said that they have to admit that automaticity is a huge issue when it comes to whole number operations, but not with fractions or geometry.

Dr. Schmid stated that when they talk about automaticity in particular, that is an issue that cuts across subjects. But with automaticity of number facts, there is a qualitatively different weight to that. He sees no problem with mentioning a particular issue twice, first in the context of memorizing number facts, and then again as a general principle.

Chair Faulkner stated that he hears the Panel saying it wants to follow Dr. Clements' group's suggestions to take the first section and move it to the end of the content area right after the old Benchmarks section.

Chair Faulkner then moved to a discussion of the actual content of what is in each of the sections.

The Readiness section includes the mathematics that children learn from preschool through the middle grades, then whole number arithmetic.

Dr. Loveless stated that under letter F, China is not a good example to use, as it only participated in one international assessment, and there were sampling problems. He recommends substituting Singapore to use as the example of a high-achieving country.

Dr. Fristedt asked about the research behind some of the items, for example, do they really know that the elementary school textbooks in this country do not have enough double and triple digit addition and multiplication problems?

Dr. Clements stated that Dr. Embretson's research, for instance, looks specifically at textbooks from other countries and the United States, so there is empirical research that has compared those.

Dr. Stotsky asked whether they should reference the studies. Chair Faulkner stated that they would check all of that and decide whether they need to use citations in the Final Report of the Panel or whether we want to leave the citation record in the Task Group reports.

Dr. Fristedt stated that he noticed, for example, in 1-B, that a very controversial topic is being discussed. He suggests that when they know the topic is going to be controversial, they should do a little more to indicate the research base.

Dr. Reyna recommended having pages or line numbers of the original task group reports. It would not interfere with the prose.

Dr. Siegler pointed out that J under the Whole Number section, on page 5 of the written document, would be better stated in the General Principles of Learning section because it applies to all the sections equally.

Dr. Boykin addressed points F and G on page 5, noting that it wasn't clear to him why those were in that section rather than in the Instructional Materials and Practices section on textbooks and curriculum.

Dr. Ma asked about Whole Number Arithmetic, item F. She stated that in U.S. elementary schools, there is much more column computation versus horizontal computation compared to other countries, which may contribute to the learning of algebra. Dr. Fennell agreed and wondered how to amend the statement. Dr. Benbow asked if it should be a separate recommendation. Dr. Geary stated that this particular statement is trying to reference the fact that practice of difficult problems is not well built into the curricula. But he agrees that the point about the horizontal presentation is a very big point. He agrees that it should be a separate point.

Dr. Loveless asked if they have empirical evidence about Dr. Ma's suggestion. Dr. Ma replied that in China, they introduce the column computation when children learn addition of two digit numbers. In Russia, they start even later with addition of three digit numbers. But she does not have the data.

Dr. Schmid stated that this point should be addressed by one of the task group reports, which he assumes is not the case at the moment.

Dr. Ball stated that the Panel could argue this logically. If they know that in algebra things are represented horizontally, then they can make a claim directly from the mathematics that it's important for students to have experiences with that format. Dr. Siegler stated that there is a widespread impression that what Dr. Ma stated is very likely true. He thinks it would bear mentioning someplace either in the Learning Processes or Instructional Practices group. But he shares Dr. Loveless' reluctance to put it in the summary report because they do not have the research on it. Mr. Williams asked if they have looked for research on that question. Dr. Geary stated that they did see in the research on the processing of linear equations in algebra that students are not processing them the way those who are skilled in mathematics would process them.

Dr. Benbow asked if this could be a research question. Dr. Loveless stated that this would be possible, but they have to know more about the existing research base on this. Dr. Benbow asked if someone was going to address it. Dr. Geary stated that they could find a place for it as a speculative statement in their report.

Dr. Ferrini-Mundy stated that this might go well with the research on the equal sign. Dr. Geary stated that would be possible.

Dr. Fristedt asked about the interplay between research and professional judgment that comes up a lot. While professional judgment is important, what worries him is when it is used to go from the research to the actual statements made in the document.

Dr. Stotsky also raised a concern about the statements not having many of the necessary qualifications that they actually have back in the original documents. Chair Faulkner stated that the appropriate text would be transported and put together using the language in the working papers

Dr. Boykin stated that he thought Abt Associates was brought into this vetting process to try to determine the empirical veracity of claims made in the task group reports. So there is at least that element that's there as sort of a safeguard for claims that

are specifically backed up by data. Chair Faulkner stated that that is quite accurate. Abt has checked what we have asked them to check. They have not taken the position that they are the insurer of everything the Panel has written. The Panel is supposed to be the insurer of what they have written.

Dr. Reyna stated that the issue of qualification would also be partially addressed by the suggestion to indicate the places in the original task group reports where these points are discussed in more detail.

Chair Faulkner then addressed the section on Acquiring Knowledge and Skills Needed to Learn Algebra and Section 1, the General Principles of Learning.

Dr. Whitehurst had a concern about a statement on the second page, the sentence just before letter H, which states, "Gender differences are small and a focus on sex differences has distracted from the task of raising the scores of both boys and girls." He stated that sex differences did not used to be small and to claim that focusing on them and seeing some progress over the last 20 years has been a distraction is an unnecessary claim. He also pointed out that one might also take the perspective that girls do substantially better than boys on other subjects, like reading. And so perhaps what has emerged as equality, at least in elementary and middle school, represents girls and women still undershooting what they would be capable of doing if they did not continue to have self-perceptions about math that can be defeating. He does not see the necessity for that statement.

Dr. Geary stated that in the Learning Processes report, they asked Abt and Science and Technology Policy Institute (STPI) to put together estimates of sex differences at the mean and at the extremes for many national databases, and the mean differences are very small. The mean differences have always been much smaller than they have been at the extremes. Girls have been getting better grades in mathematics for the last two and a half, three years. He agrees that the sex differences in writing and reading are very robust and have not changed much. He feels that the mechanisms underlying those different patterns of performance are different. He would like to see them state something like the differences are small, but we need to improve the mathematical achievement of both boys and girls. Dr. Clements asked whether this belongs as one of the major messages that will change policy in a constructive way. Dr. Geary stated that one potential point is lots of resources are being focused on improving the performance of girls, which is fine, but it is based on perception that there's a large intractable gap. The mean differences show that it is not the case. It is the case when we look at extremes. A lot of money is being targeted in ways that might be better spent to improve performance of both boys and girls.

Dr. Reyna added that one way to separate these issues is to talk about the difference between ability, which this statement addresses, and attainment. And both of those are policy relevant, but they cut in somewhat different directions. What they wanted to convey here was that there is no evidence about inherent ability. There's also some recent work that shows that very limited practice and experiences will narrow this gender gap considerably. The other issue has to do with attainment, and they do not have the evidence there to know why the attainment is so different in terms of careers in science and mathematics.

Dr. Loveless asked what the factors refer to in items E and F that begins, "Other factors include attitudes." Where the second part says, "And school-based factors such as

features of teaching and learning context," he feels this is very vague. He feels that the experimental evidence on stereotype threat needs to be emphasized in F, the list of items including stereotype threat. He thinks the evidence is much weaker for cognitive load, strategy use, task engagement, self-efficacy, and teacher involvement. .

Dr. Embretson stated that she would make the opposite suggestion about stereotype threat, to not separate it out. The procedures that were used to review the literature did not pick up technical reports from major test publishers, who in fact have looked at stereotype. Dr. Loveless stated that those are two different things.

Dr. Reyna added that it depends on how they summarize literature. When people obtain null effects, as they said in their standards document, especially non peer-reviewed null effects, she does not think that it counts either for or against a claim. Based on the published peer reviewed top journal type evidence, there have been interventions that have shown significant effects.

Dr. Embretson stated that she still counters because everybody knows that null findings are not really well accepted by journals. The studies she is referring to in fact are not published because they are not findings that are intriguing in that sense.

Dr. Fristedt asked that points J and K stay as is.

Chair Faulkner then moved to a discussion of Section 2, Readiness for Learning.

For the last two points, F and G, Dr. Sielger's group recommended changing the wording because there was a concern that it might seem too self-serving. They would like to say that a variety of instructional programs, developed to improve the mathematical knowledge of preschoolers and kindergarteners, especially those in at-risk backgrounds, have yielded encouraging results. There is a need to invest in research on effective preschool interventions. Dr. Reyna asked if all the research findings and recommendations should go at the end.

Dr. Fristedt asked if they could mention some of the instructional programs that have been developed in E. The one he has in mind is the one that Cynthia Jones mentioned at the public session in Chicago, where the slow learners had a special seminar. Dr. Reyna stated that there might be issues with endorsing that particular thing, especially since they do not necessarily have peer-reviewed literature. She would mention, though, number line training, board games that involve counting, or part-whole games, which do have peer-reviewed evidence.

Dr. Fristedt noted, in connection with the number line, that even though Learning Processes paid quite a bit of attention to understanding inequalities on the number line, he did not see much attention to using the number line to represent addition and subtraction, and that it can carry over to fractions. Dr. Reyna responded that there is research on it and it does carry over.

Chair Faulkner moved the discussion to Number Sense, which is Section 3 on page 5.

Dr. Schmid asked about 3-A, which starts out with number sense and proficiency at approximating numerical magnitudes. It then moves to say, "Such proficiency," because now that refers to proficiency at approximating numerical magnitudes. There's then a list of components, which are important on their own not just because they make it possible to approximate numerical magnitudes. The paragraph is not clear.

Dr. Fennell noted that important information was lost here. The issue of magnitude is an element of number sense.

Dr. Siegler stated that the second sentence could begin "Among the key elements of number sense are," and then continuing with understanding of place value, how numbers could be decomposed and recomposed.

Dr. Fennell agreed to rewrite this.

Dr. Geary stated that his group discussed whether they want to separate number sense into those areas which students seem to have inherently and early on. This is very different from the number sense that emerges as a result of good mathematics education.

Dr. Ball stated that C, D, and E in this section seem misfitting. There are lots of things that are involved in improving students' number sense. D and E seem like recommendations about instruction and about textbooks. C seems like a throwaway that can be deleted.

Dr. Clements asked about E and whether we know the assertions about textbooks.

Dr. Schmid stated that E does not particularly apply to whole number arithmetic. It is a much more general comment that does not belong in this section. The purpose of estimation is something that comes long after whole number arithmetic. In whole number arithmetic and in number sense there should be some sense of order of magnitude and this is being said already. They do not want to advocate that in textbooks there be a formal discussion of the purpose of estimation in the context of whole number arithmetic.

Dr. Ferrini-Mundy stated that there are four content sections in this overall section and three of them map directly to the Critical Foundations. This one does not. That is confusing. The Panel should try to keep the emphasis on number sense, but maybe the number sense part is rolled in to the whole number section and maybe the estimation. Dr. Schmid stated that the issue of estimation in the context of whole number arithmetic is already in A, and this is exactly the right kind of emphasis to give on estimation at that grade level.

Dr. Ma stated that she does not like the term number sense because it is very vague. She asked if there was any scientific research saying that place value belongs to number sense. Dr. Siegler stated that the research on its importance comes from understanding of fractions. Place value is a key part of number sense because if children do not understand the decimal system and place value, they make these very basic mistakes. They also make similar mistakes in fractional arithmetic, because they come up with answers where they are adding two fractions and they come up with a number that's smaller than either of them.

Dr. Wu stated that this is about understanding the meaning of numbers or the particular representation of numbers. If we define number sense to be an understanding of the numeral system that we have, then of course number 10 is correct. Mr. Williams stated that prior to this Panel, he had never heard of number sense. He feels they should call it conceptual understanding instead. If they want teachers to pay any attention to this document, they have to use terms teachers know. Number sense will not be understandable.

Dr. Fristedt stated that estimation should come after people know what they are doing, and it should not be emphasized too early. He also stated that estimation fits so naturally with inequalities, but the connection does not seem to be anywhere in anything they have done.

Dr. Fennell stated that the goal for students, in particular in the learning of mathematics prior to algebra, ought to be a robust sense of number. And he would define that as being proficient in the kinds of algorithms and procedures in Critical Foundations. This is also having a sense of where those numbers fall on a number line, be they decimal representation or mixed fractions and decimal representations with common percents, or whole numbers early on. It is also the ability to estimate. Dr. Schmid stated that number sense includes a decimal system of numerical expression. He added that in math education number sense is widely understood at the elementary school level and is terminology that exists. Mr. Williams does not think it is understood.

Dr. Reyna added that maybe number sense could be defined as an accurate intuition about numerical magnitudes as exemplified by performance of the following tasks, and then give examples of the place value, and so on and so forth.

Dr. Schmid asked if schools of education are teaching this term. Dr. Ball stated that it's broadly used. Whether it's broadly understood to mean what they want it to mean, she could not speak to that. But it is a very common term.

Chair Faulkner stated that they will take the recommendations that are in D and E and move them to the recommendations section. And then they will decide later whether they're important enough to try to keep in the recommendations section. They also will take out C.

Dr. Siegler disagreed about the removal of C. He feels it has a lot of content. "Improving young children's number sense improves a wide variety of other mathematical capabilities, including estimation on number lines, magnitude comparison, counting, identification of numerals, and addition." Mr. Williams asked how one could improve a student's number sense. Dr. Siegler responded that this is not a definition, but an empirical finding that when preschoolers play numerical board games that are linear, going from zero to 10, they get a sense of the magnitude of numbers. Students who played the game with the numbers learned more of the addition problems and their errors are closer in magnitude than kids who played the same game but not with numbers.

Chair Faulkner stated that C would be moved to the recommendations section. Dr. Fennell, Dr. Schmid, Dr. Geary, and Dr. Siegler will help define that.

The meeting was adjourned at 5:05 p.m.

I certify the accuracy of these minutes.

Chair Signature _____ Date _____

Vice Chair Signature _____ Date _____

ADDENDUM: PUBLIC PARTICIPANTS

First Name	Last Name	Organization
Daniel	Battery	Arizona State University
Judy Ann	Brown	Words and Numbers, Inc.
Jennifer	Chintala	Pearson Education
Shannon	Ferguson	Peoria Unified School District
Anita	Greenby	Companleniz
Carole	Greenes	Arizona State University Polytechnic Campus
Rodrigo	Gutierrez	University of Arizona
Cheryl	Keenan	U.S. Department of Education
Lisa	Koenig	Deer Valley Unified School District
Suzi	Mast	Kyrene School District
William	McCallum	University of Arizona
Christie	McDougal	Arizona Department of Education
Lynda	McKelvey	Sopris West Educational Services, A Cambium Learning Company
Cynthia	Olas	Tempe Union High School
Sharon	Prado	Arizona State University
Janie	Zimmer	National Council of Supervisors of Mathematics, Research Based Education